Question	Scheme	Marks	AOs
8(a)	$A = 1000$	B1	3.4
	$2000 = 1000e^{5k}$ or $e^{5k} = 2$	M1	1.1b
	$e^{5k} = 2 \Rightarrow 5k = \ln 2 \Rightarrow k = \ldots$	M1	2.1
	$N = 1000e^{\left(\frac{1}{5}\ln 2\right)t}$ or $N = 1000e^{0\,139t}$	A1	3.3
		(4)	
(b)	$\dfrac{\mathrm{d}N}{\mathrm{d}t} = 1000 \times \left(\dfrac{1}{5}\ln 2\right)e^{\left(\frac{1}{5}\ln 2\right)t}$ or $\dfrac{\mathrm{d}N}{\mathrm{d}t} = 1000 \times 0.139e^{0\,139t}$ $\left(\dfrac{\mathrm{d}N}{\mathrm{d}t}\right)_{t=8} = 1000 \times \left(\dfrac{1}{5}\ln 2\right)e^{8\times\frac{1}{5}\ln 2}$ or $\left(\dfrac{\mathrm{d}N}{\mathrm{d}t}\right)_{t=8} = 1000 \times 0.139e^{0\,139\times 8}$	M1	3.1b
	$=$ awrt 420	A1	1.1b
		(2)	
(c)	$500e^{1\,4\times\left(\frac{1}{5}\ln 2\right)T} = 1000e^{\left(\frac{1}{5}\ln 2\right)T}$ or $500e^{1\,4\times"0\,139"t} = 1000e^{"0\,139"t}$	M1	3.4
	Correct method of getting a linear equation in T E.g. $0.08T\ln 2 = \ln 2$ or $1.4 \times "0.339"T = \ln 2 + "0.339"t$	M1	2.1
	$T = 12.5$ hours	A1	1.1b
		(3)	
		(9 marks)	
	Notes		

Mark as one complete question. Marks in (a) can be awarded from (b)

(a)

B1: Correct value of *A* for the model. Award if equation for model is of the form $N = 1000e^{\;t}$

M1: Uses the model to set up a correct equation in *k*. Award for substituting $N = 2000, t = 5$
   following through on their value for *A*.

M1: Uses correct ln work to solve an equation of the form $ae^{5k} = b$ and obtain a value for *k*

A1: Correct equation of model. Condone an ambiguous $N = 1000e^{\frac{1}{5}\ln 2t}$ unless followed by something

incorrect. Watch for $N = 1000 \times 2^{\frac{1}{5}t}$ which is also correct

(b)

M1: Differentiates αe^{kt} to βe^{kt} and substitutes $t = 8$ (Condone $\alpha = \beta$ so long as you can see an attempt to differentiate)

A1: For awrt 420 (2sf).

(c)

M1: Uses both models to set up an equation in *T* using their value for *k,* but also allow in terms of *k*

M1: Uses correct processing using lns to obtain a linear equation in *T* (or *t*)

A1: Awrt 12.5

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Answers to (b) and (c) appearing without working (i.e. from a calculator).

It is important that candidates show sufficient working to make their methods clear.

(b) If candidate has for example $N = 1000e^{0.139t}$, and then writes at $t = 8$ $\dfrac{dN}{dt}$ = awrt 420 award both

marks. Just the answer from a correct model equation score SC 1,0.

(c) The first M1 should be seen E.g $500e^{1.4 \times "0.139"t} = 1000e^{"0.139"t}$

If the answer $T = 12.5$ appears without any further working score SC M1 M1 A0

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